Contribution ID: **15** Type: **not specified**

Ab initio calculations of nuclear thermodynamics

Friday, 27 July 2018 15:00 (20 minutes)

We present the first ab initio calculations of nuclei and nuclear matter at finite temperature. Using lattice Monte Carlo simulations and chiral effective field theory, we probe the thermal properties of nuclear systems from first principles. We find that the pinhole algorithm, initially developed for extracting nucleon densities, is well suited for computing the canonical partition function. We employ a chiral nuclear force fitted to nucleon-nucleon scattering data on the lattice and calculate a variety of thermodynamic quantities for light nuclei, dilute neutron matter, and dilute nuclear matter, such as the free energy, entropy, and specific heat. The pinhole algorithm is found to largely alleviate the sign problem, which prevented previous attempts in this direction.

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Session Classification: Nonzero Temperature and Density

Track Classification: Nonzero Temperature and Density